The Scientific Method

(for Experiments)

Question

What do I want to learn? What happens if? Which is better/more/stronger/faster? Why does? How long? Can this animal learn to do such-and-such?

1. A Research

Has anyone else asked the same question? If so, what have they learned?

Hypothesis

What is my "best guess" of the answer to my question?

Plan Experiment

How will I perform my experiment? Which variables are important? What materials do I need? How much time will this take? What will be my step-by-step procedure?

Perform and Observe

Take data, write down observations, perform more than once to check validity of the data, change the experiment if it can be easily improved.

Results

Plot data on a graph and compare results. Compare written observations. Describe what you think happened in words, pictures (sketches, diagrams), graphs, equations.

Conclusions

What happened, and why? How does it answer your question? How does it compare to your hypothesis? (It's OK if your hypothesis was wrong – that's how scientists learn new things!) How could you improve the experiment?

The Design Method

(for Inventions)

Problem

How can I do this job easier, better, more efficiently? Do I need to improve a previous invention, or make a new invention?

1A. Research

Has anyone else had the same problem? If so, what have they learned? How did they solve it?

Idea

Here's my idea of how to solve this problem. (This is like a hypothesis.)

Design

What does my invention need to do? How do I design it to do the job? How do I make it strong enough, light enough, efficient enough, dependable enough?

Build and Test

Build the invention. Design a test (like an experiment). Test it to see if it will perform as designed. Test it to see when it will not perform as intended. Take data. Write down observations. Test it several times for repeatability.

Results

Plot data on a graph and compare results. Compare written observations. Describe what you think happened in words, pictures (sketches, diagrams), graphs, equations.

5A. Re-design, re-build, re-test (if necessary)

Conclusions

What happened, and why? Does it solve your problem? Will you like it and use it? Will other people like it and use it? How might your invention be further improved?

The Model Method

Why Build a Model?

What scientific topic do I want to understand better? Or, what topic do I want someone else to understand better? What model can I build to explain it? (Example: How does a volcano erupt?)
Comment – Sometimes a model can be a "kit" (building a volcano, building an electrical circuit, building a solar system). Sometimes a model can be a science demonstration (show how static electricity can make your hair stand up, show how light is made of different colors, build a model showing how the heart pumps blood).

Research

What is known about your topic? (Example: A volcano erupts because of the pressure of the hot lava as it builds up under the crust. It builds up pressure until it pops like a balloon or breaks like an overstuffed garbage bag.)
Has anyone else built a model of this before? How did they do it? (Example: One way to build a volcano is with papier mache, chicken wire, a big tube, vinegar, baking soda, soap bubbles, and food coloring.)
How does the model help me understand the real thing? (Example: The mixture of baking soda and vinegar builds up pressure and forces its way out of the top of the volcano. This shows how fluid under pressure tries to go somewhere with less pressure.)

Build and Test

Build the model. Make sure the model works the way it is supposed to work. Make sure the model can explain a scientific idea or process. (Example: A fluid moves from a high pressure place to a low pressure place. The baking soda and vinegar are like lava because they are pressurized and try to move to the surface.)

Explain

How is the model like the real thing? (For the volcano: the fluid builds up pressure, and comes to the top; the fluid flows like lava, and eventually hardens like lava; the red food coloring and soap bubbles make the fluid look like lava.)
How is the model not like the real thing? (Lava is very hot, baking soda and vinegar are not; a real volcano builds up much more pressure, which sometimes makes an explosion; molten rock is heavy and can move trees, baking soda and vinegar are not.)

Report

Write your report; be able to tell others about your model (oral report); explain the processes using scientific words (pressure, heat, lava, magma) and ideas (fluids move from high pressure places to low pressure places).